Improving cognitive independence of dementia patients using machine learning-enabled mobile application

Project Id: 2023-081

Project Proposal Report

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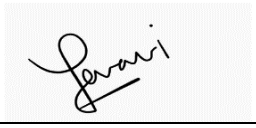
Madhubhashini A.D.P.	IT20174576	

Under my supervision, the above candidates are conducting research for their undergraduate dissertations.

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Abstract

Dementia is marked by severe mental decline, which may be expressed as challenges in performing Activities of Daily Living and Instrumental Activities of Daily Living. This results in a vulnerable population of people who do not have proper support (National Collaborating Centre for Mental Health, 2007) [9].

It causes patients to have trouble recalling the identities of familiar faces. In addition, patients often struggle to communicate with others around them. The objective of this research is to propose a smart solution based on a facial recognition system to help dementia patients recognize their loved ones and address the challenges faced due to short-term memory impairment. To address this, our application utilizes facial recognition technology in conjunction with a description of the person photographed and the smartphone camera.

This enables the patient to identify their loved ones. Additionally, we hope to present the patient with memories or videos of the person in the photo. In this proposed study, we implemented a convolutional neural network-based(CNN) facial recognition system integrated with a smartphone camera and person description feature. The application could be a useful tool for patients to identify their loved ones and enhance their interaction with the people surrounding them. Further studies could explore the effectiveness of the proposed application in clinical settings

Keywords— Neural Network, Dementia, short-term memory impairment, face recognition technology, Cognitive disability

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1. Introduction

1.1.Background and Literature Survey

Dementia individuals are people who have experienced a significant loss in their cognitive and memory functions, which causes significant difficulties in their day-to-day lives and activities. It is a degenerative disorder that has a gradual impact on a person's thinking, memory, conduct, and capacity to carry out activities of daily living.

The World Health Organization estimates that there are 35.6 million people living with dementia, and that number rises by 7.7 million per year. This figure is expected to double by the year 2030 and triple by the year 2050 [1]. Dementia has significant physical, psychological, social, and economic effects on caretakers, families, and community due to the decline in memory, cognition, and ability to carry out everyday tasks [1].

Many kinds of research have shown that incorporating touchscreen technology into cognitive stimulation therapy can improve cognitive function in older people with dementia[2].

As a consequence of advancements in medicine and technology, the geriatric population and life expectancy are both increasing. It is anticipated that the amount of individuals with Alzheimer's disease will nearly double in every 20 years [1].

Patients with dementia frequently experience short-term memory impairment, which is directly affect their independence, making it challenging for them to recognize familiar faces, including their own and those of their friends and relatives [3],[4]. In this situation, patients need to get support from a third party to recall their memory. This situation can have a profound emotional impact on both dementia patients and their relatives and other loved ones.

With the purpose of creating an assistive tool for identifying familiar faces, we conduct a survey of random 50 people in the society. According to the survey that we conduct, the majority of people respond about the emotional impact. (Figure 1.0). This is one of the major problems that have for dementia patients and their loved ones.

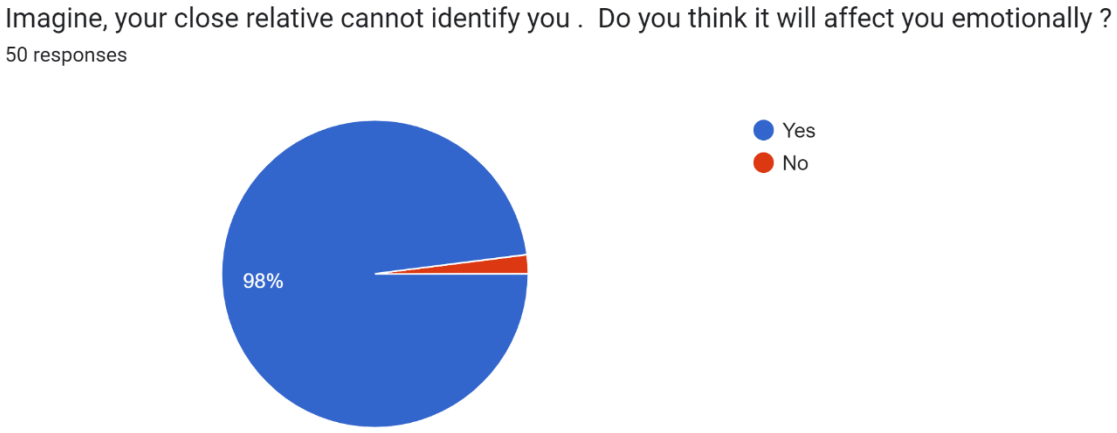

Figure 1.0: Survey results that about the emotional impact

In addition to that, the family also takes on the role of primary caregiver, which is frequently an emotionally challenging and very stressful job. One-third of individuals with depressive symptoms were family caretakers.. Initially, it can be quite difficult for the distant caregiver to continuously monitor patients as not everyone is living closer by [5]

According to medical data, in Asian countries, most dementia patients live alone, without any caregivers. Therefore, they cannot always get a help from third party to maintain their day-to-day lives. As the people who know the value of independency, we want to improve their quality of life and make them more independent.

As shown in figure 1.1 our survey shows that the majority of participants considered the importance of identifying their loved ones and familiar faces to maintain an independent life.

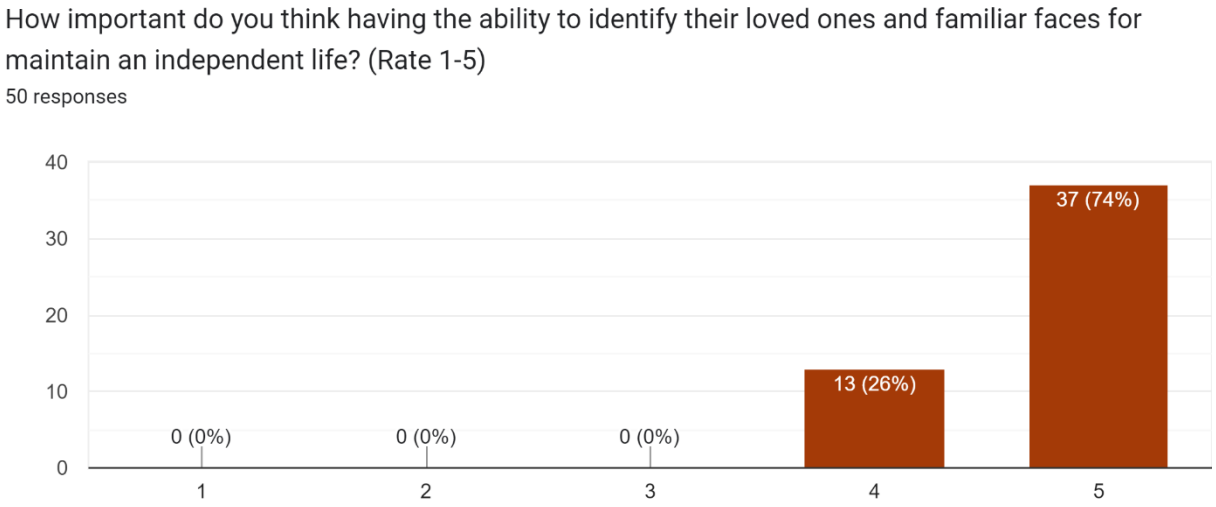

Figure 1.1: The importance of the ability to identify faces

Even though there are traditional solutions like having a caregiver to aid these kinds of individuals to recall their memory, since not all caregivers live in close proximity, remote monitoring may be a challenge[5]. As shown in figure 1.2 our survey shows that most people in society think all dementia patients haven't the ability to keep a caregiver for their day to lives.

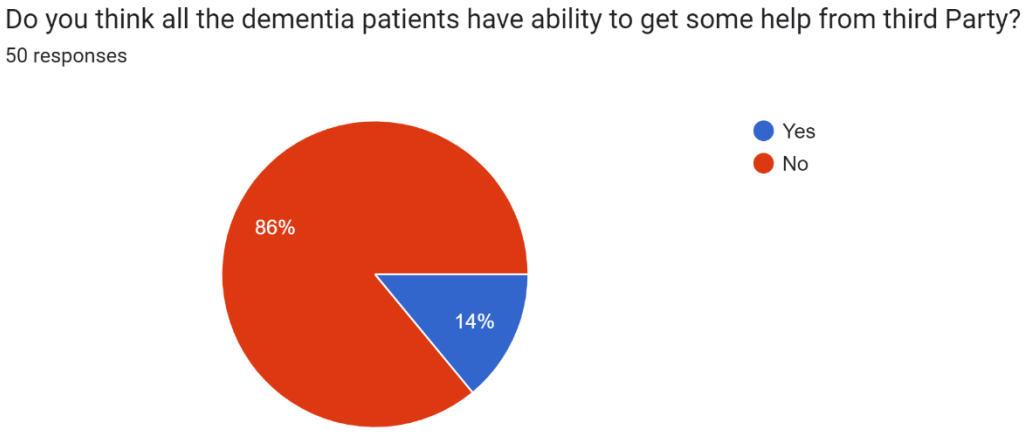

Figure 1.2: Survey results that regarding the help of third party

According to the Sri Lankan hospital data, most mild and moderate-level dementia patients spend their time alone. And the other main considerable thing is the cost of caring for a patient with dementia is high. Seven out of ten people with the condition live at home, where their families pay for the majority (75%) of their maintenance. As a solution to this issue, we ask what the effective and easy ways are to avoid those difficulties. Then we received some answers as shown in figure 1.3. Majority of the society, agree with making an assistive tool for dementia patients to identify their familiar faces is the most efficient and effective way to improve their quality of life.

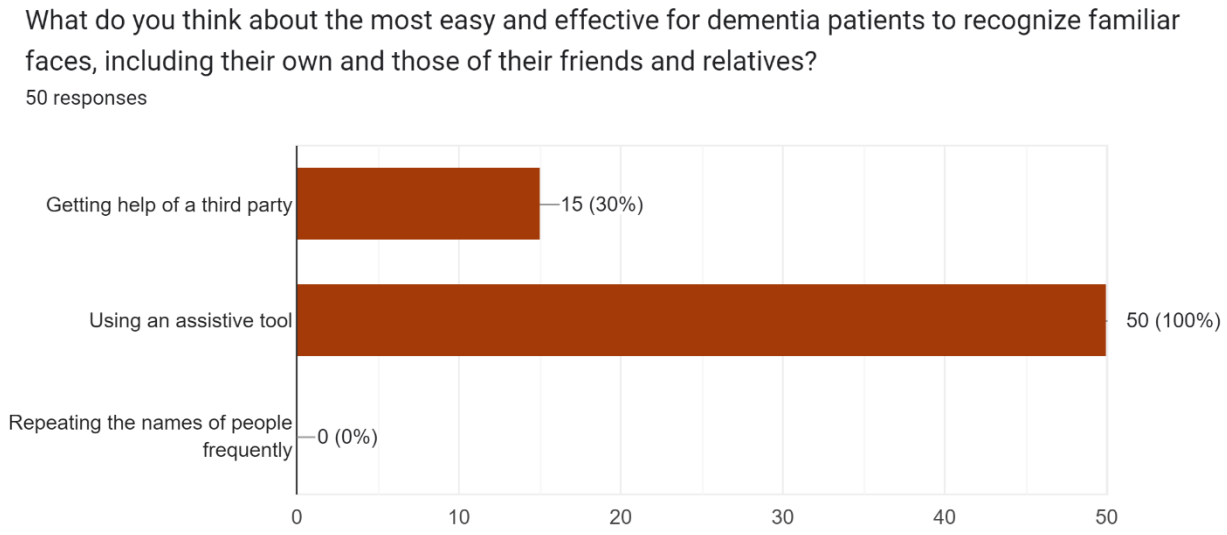

Figure 1.3: Survey results that display the effective and easy way to recognize familiar faces of dementia patients

1.2 Research Gap

Comparing recent research on facial recognition applications and dementia patients there is very lack of research exploring the effective and efficient system for targeting directly the dementia patients. When studying the literature points, various tools have been built to recognize faces, and several assistive tools have also been implemented for normal people. Most of the existing solutions are implemented for a limited audience and lack functions.

Caregiving is a non-pharmacological treatment for the dementia patients. Caregivers are frequently investigating the patients' behavior. Non-pharmacological management of dementia puts a burden on those who are taking care of a patient[5].

Most existing facial recognition software is designed for use by caretakers, giving them aid in keeping a close eye on their dementia patients. The uniqueness of our solution and others is that it was developed with the input of people living with dementia, considering their preferences, skills, and limitations.

Knowing that people with dementia have cognitive impairments, we designed facial recognition software specifically for them. The interface and functionality have been developed with individuals with dementia in mind, making them easy to use and accessible. The application sets a priority on the user's capacity to identify familiar faces, which in turn provides the individual with a feeling of comfort, safety, autonomy, and independence.

As shown in figure 1.4 most people suggested us to create an assistive tool with a facility of memory-recalling option of the captured person.

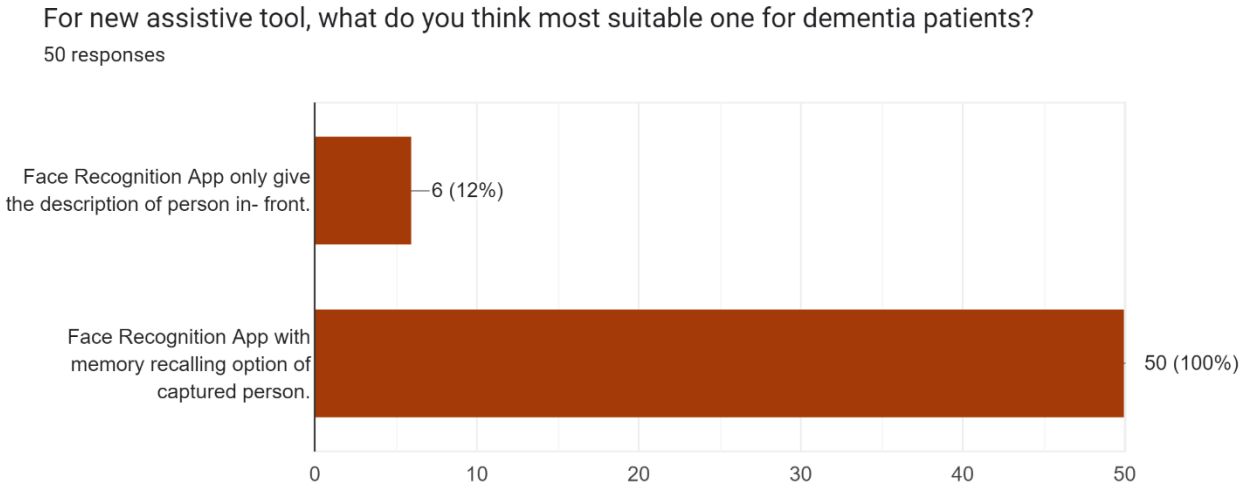

Figure 1.4: Survey results that display the most suitable assistive tool for dementia patients

Furthermore, our solution goes beyond just face recognition and adds value by incorporating additional features that are beneficial to dementia patients. For example, instead of providing a brief introduction of the person (name and the relationship between the patient), it may include prompts for memory slides regarding the captured person after detecting the person's face. These features are specifically tailored to address the needs of dementia patients, make them more interactive, promoting their well-being, and independence

Face detection can be done in many ways, but when it comes to dementia, we must think a lot about the user interface also. We must use large icons and large fonts for the minimal distraction and ease of patients. Furthermore, many existing face-detection applications are not specifically created for dementia patients [6](Research A)[7]. People suggest us to add some features [figure 1.5] from their perspective to the proposed face recognition app for make it more effective to improve the effectiveness and efficiency of that application.

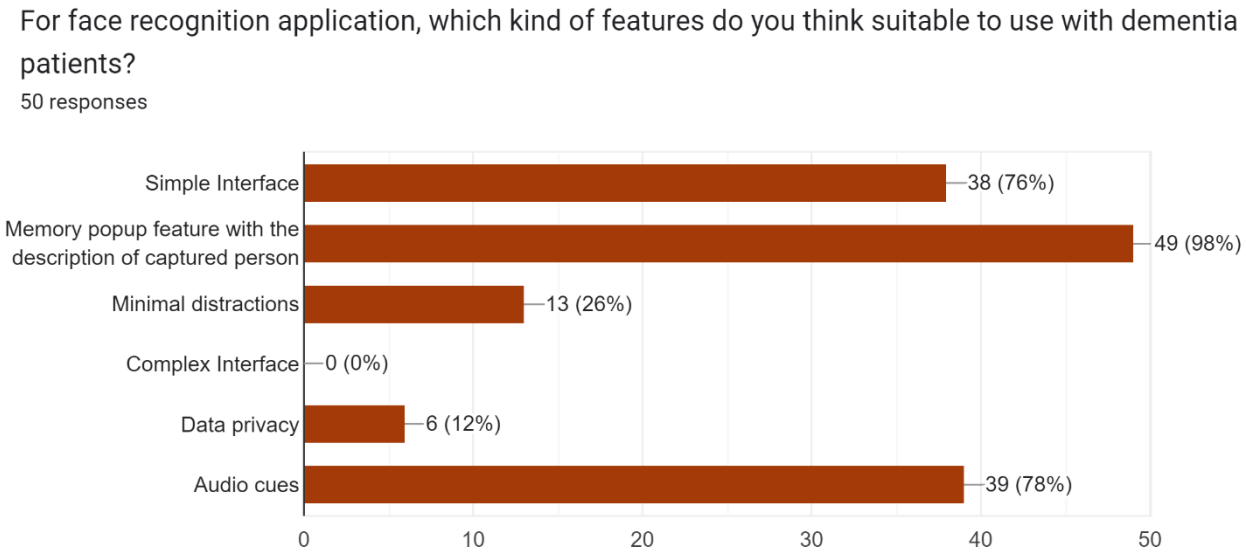

Figure 1.5: Survey Results that display the suitable features for the proposed app

We found some face recognition applications for dementia patients, but they only display the description of the person who is captured in the phone camera[4](Research B). Some existing applications are not real-time face recognition features[3](Research C) [14] . Furthermore. the results of the survey indicate that most of the participants think that the face recognition application will be more effective in assisting with memory recall function. Because it helps patient to recall their memory with that person and additionally it affects their entertainment also. And we found out dementia patients are interested in visual screening. The results that we are get, shown in figure 1.6.

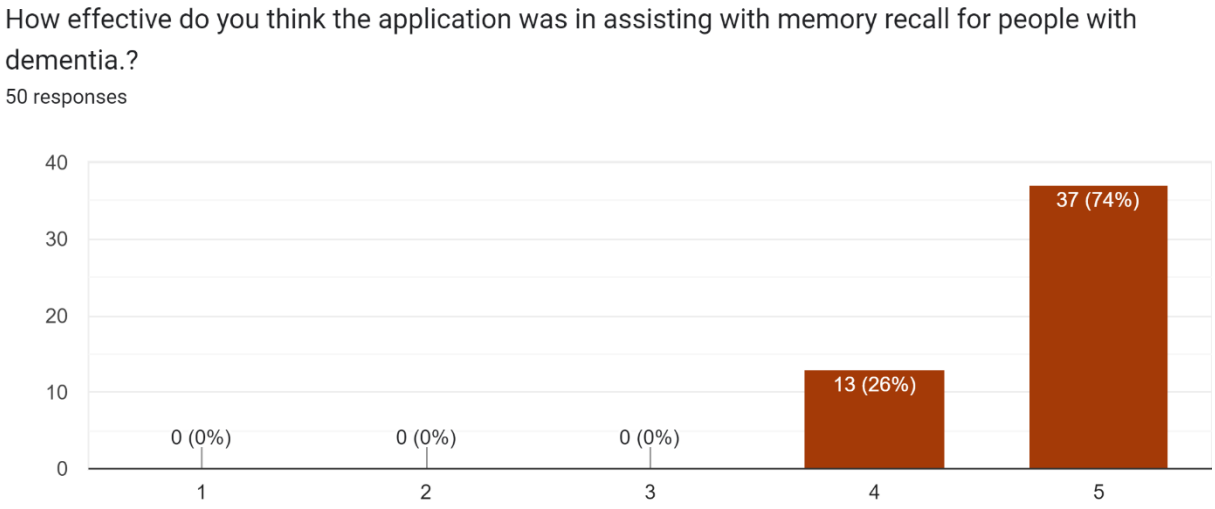

Figure 1.6: Survey results that display the effectiveness of memory recall interactive option

And furthermore, when comparing existing researches and other solutions(Research A, B) they only provide the name and the relationship of that captured person.

Most of the dementia patients are elderly person, therefore they may have some difficulties to read the content on the screen. To overcome with this problem, in our proposed solution also provide that feature with a voice output to hear the content screening in addition to see the details on the screen.

Our solution also emphasizes the importance of maintaining the dignity and privacy of dementia patients.

According to our survey, people are not aware of the existence of face recognition apps with memory popup feature for dementia patients. Shown in figure 1.6.

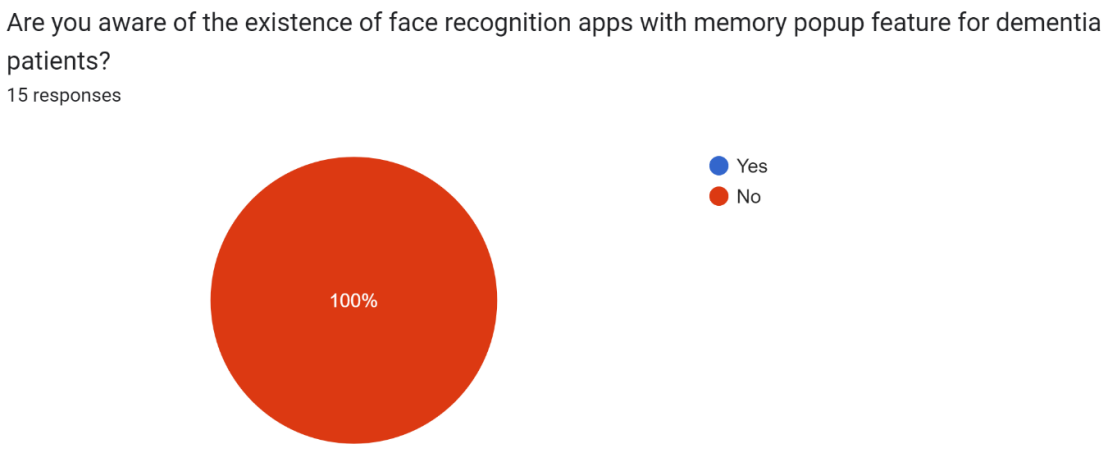

Figure 1.7: Survey results that display the existence of memory popup face recognition App

In below mentioned table display the summary of the comparison of the existing solutions and the proposed solution. By reviewing below table, you can come with an idea that what are the novelties of the proposed solution.

Table 1.1: Research gap for document segmentation and classification with the existing system

Features	**Research A**	**Research B**	**Research C**	**Solution**
A real-time image-capturing option using the smartphone camera	X	√	X	√
Screening the person's Information	√	√	X	√
Use a text-to-speech module to hear the information	X	√	X	√
Special user interface creation for dementia patients	X	X	√	√
Use object recognition mechanism to filter a memory, related to the captured person	X	X	X	√

1.3 Research Problem

Dementia is defined as a general cognitive impairment, which may be expressed as challenges in performing Activities of Daily Living and Instrumental Activities of Daily Living. (National Collaborating Centre for Mental Health, 2007) [9]. When we consider the existing research solutions and the dementia patients there is a lack of research exploring the effective and efficient system for targeting the dementia patients. Although most caregivers live with the patients, about 15% are act as long-distance caregivers, residing at more than one hour's drive away. This kind of situation makes constant monitoring of patients extremely difficult for these remote caregivers[5]. Other problem is caregivers are very costly these days.

According to our external supervisor(neurologist) , In Sri Lanka majority of dementia patients live alone without any caregiver. Therefore, every time, dementia patients can't get a third-party assistant to identify people [5].

And the most considerable thing is the inability of identifying people can have a profound emotional impact on both dementia patients and their family members. According to the survey that we were conduct majority of the people agree with the above statement(Figure 1.7). Not only that but also, dementia patients may be socially isolated in such kind of situation. And that leads to feelings of frustration, fear, and anxiety.

Therefore, for the purpose of improving their quality of life and making their lives more independent, we are developing a mobile application to address the needs of individuals with mild to moderate dementia who experience cognitive difficulties. The result will be a more intuitive and efficient human-computer interaction, making our application a valuable tool for enhancing the quality of life for those with dementia.

According to the survey conducted, figure 1.8 depicts that many people think that face recognition applications are helpful for dementia patients. Figure 1.9 says the most affected aspects of face recognition application for dementia patients.

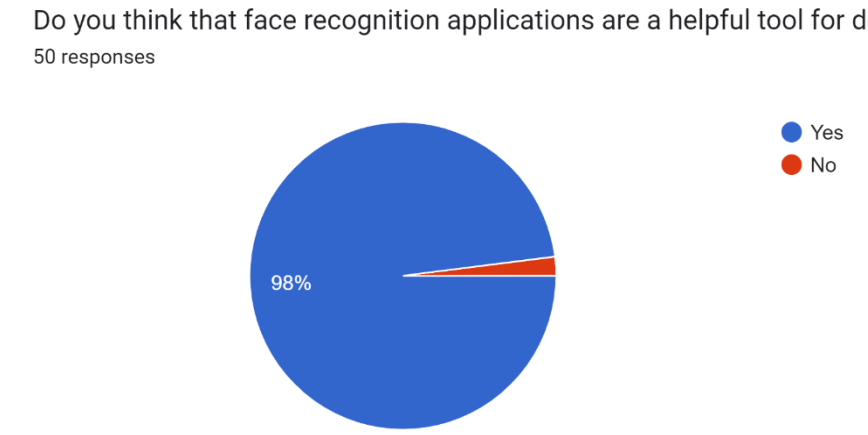

Figure 1.8:Survey results that display the importance of face recognition application helpful for dementia patients

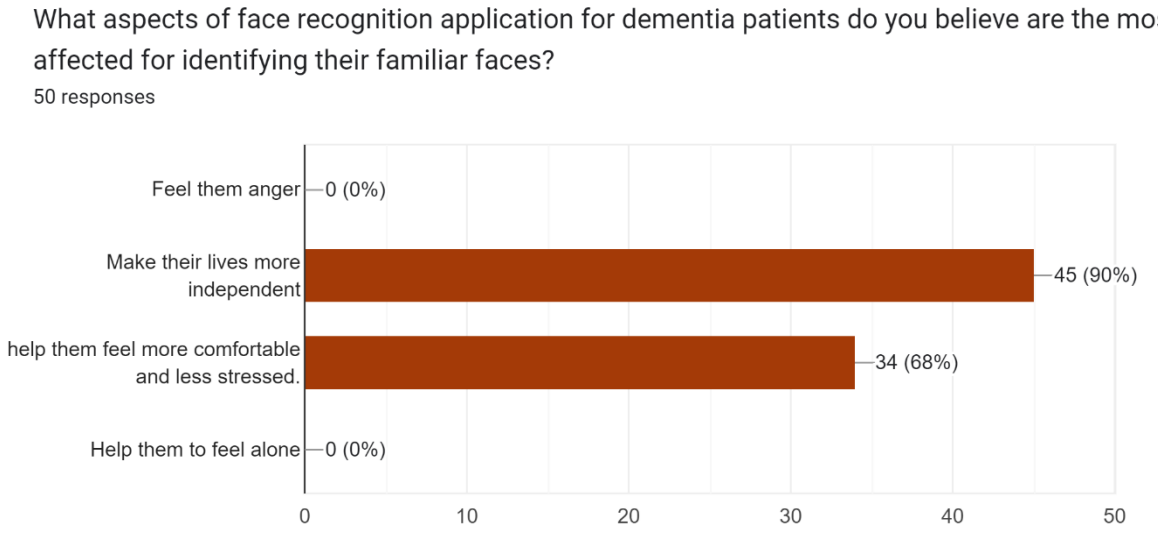

Figure 1.9: Survey results that display the most affected aspects of face recognition application for dementia patients.

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2. Objectives

2.1.Main Objectives of the proposed solution

The core objective of this research is to develop an efficient solution capable of identifying a patient's loved ones and relatives through face recognition in a manner that ensures the patient's independence. This component's input will be the person's face, and its output will be the person's details.

2.2. Sub Objectives

In addition to the main objectives, there are some specific objectives related to the implementation

- Developing the proper algorithm for detecting the familiar faces and providing the user with information about the person
- Creating a recollection of that individual or a slideshow of photos with that person for the patient to watch. Additionally, developing access to an album where he can see memory slideshows whenever he wants.
- Face detection: This involves locating faces in an image or video.
- Feature extraction: This involves extracting key facial features, such as the eyes, nose, mouth, and shape of the face, to create a unique facial representation or feature vector.
- Face comparison: This involves comparing two or more facial representations to determine if they belong to the same person or not.
- Face verification: This involves confirming the identity of an individual by comparing their facial features to those stored in a database.
- Face recognition: This involves identifying an individual by matching their facial features to a database of known individuals.
- Implement a text-speech API to get the voice output of the displayed content.

3. Methodology

Developing software to assist dementia patients in finding relations by capturing images using face recognition technology is a promising approach to improving their quality of life. The proposed system would use Neural Network Algorithms to detect and match the faces of individuals in the patient's social gallery with previously stored images and records.

To develop this software, several core functionalities would need to be implemented, including an image recognition system based on machine learning techniques, a database for storing images and personal information, and a user interface that would enable patients to interact with the application with a minimal distraction. Additionally, the system should incorporate text-to-speech API and other assistive technologies to facilitate communication with the patient.

To implement the image recognition system, neural networks (NNs) can be used. These networks have demonstrated excellent performance in facial recognition tasks, with some models achieving near-human levels of accuracy [8],[9] [10]. Once an image is captured, the system would use the neural network to compare it to previously stored images and retrieve all relevant information associated with the individual.

The user interface designing should be simple and intuitive for dementia patients [11], [12] for improve the human computer interaction of proposed solution. The interface should include features such as voice output, large fonts, large icons , and simple navigation [11]. Since we are focusing the dementia patients as the audience of this application , it should be a minimal distractive application.

To evaluate the effectiveness of the system, a randomized trial can be conducted. In this trial, participants would be assigned to the experimental group, which would use the software application. The trial would measure the changes in cognitive function and quality of life in both groups over a specified period.

In conclusion, the proposed system has the ability to significantly improve the quality of life and independence of dementia patients by providing a simple and intuitive way to access information about their social network.

3.1.System Overview Architecture

3.1.1 Software Solution

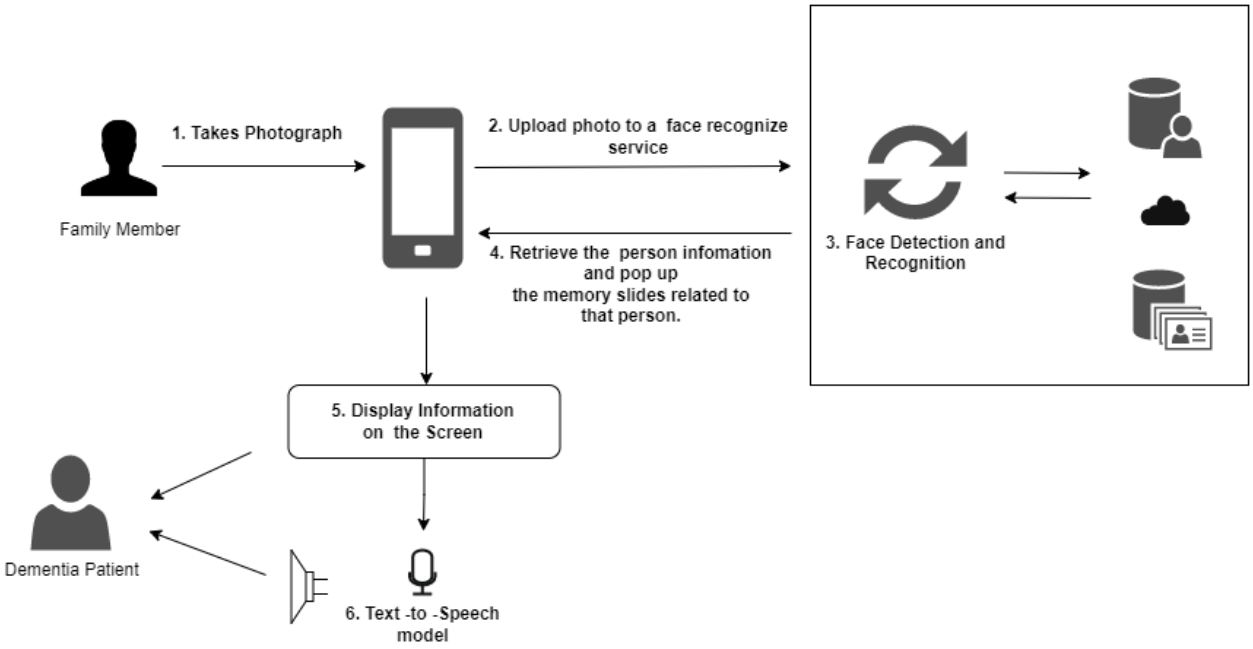

Figure 3.1: System Overview Diagram

3.2. The flow of project

3.2.1. Requirement gathering and analysis

Collecting and analyzing requirements exhaustively is the cornerstone of any research study. Before beginning the implementation phase, this important step includes documenting and analyzing every conceivable requirement for the system to be developed. Methods used to collect requirements include the following:

- Conducting a thorough review of research papers and articles
- Identifying the available tools currently in use.
- Distributing surveys to gather pertinent information.

Examining research papers is the best method for collecting requirements because it provides a clear understanding of the relevant elements. By analyzing extant tools, we can identify the gaps that the proposed component must resolve. In addition, conducting surveys enables us to collect the data and information necessary to develop a competitive tool that can match or surpass existing tools.

3.2.2. Feasibility study

The proposed system's viability can be evaluated in three main areas: schedule, technical, and economic. First, the system must be completed within the allotted timeframe, and each phase should be time-bound to ensure a product of the highest quality. A Gantt chart can be used to display each task's time constraints. Second, the researchers must have a fundamental understanding of mobile application development technologies and machine learning techniques in order to train the model. To implement the application, each member of the team must also be knowledgeable in computer programming languages. Third, the product must be developed within the constraints of the budget, and all team members must adhere to it. To accomplish the intended results, the strategy must be both economical and comprehensive.

3.2.3. Implementation

The recommended functionalities and accessibility standards would be given top billing throughout system implementation. Software architectures that allow for seamless communication between parts will be developed. All models will be developed following industry standards and trained on high-quality datasets for get maximum accuracy.

3.2.4. Testing

Unit testing, integration testing, and user acceptability testing are just a few of the approaches that will be used to ensure the quality of the final product. In order to catch bugs and problems early in the development of an application, thorough testing is required. Any problems found during testing will be fixed as soon as possible so that the final product can be released without any obstacles.

3.2.5. Commercialization

To guarantee its efficacy and safety, the commercialization of a mobile app for dementia patients entails numerous regulatory considerations. Clinical trials and regulatory body permissions might be required for the app. Moreover, funding for the creation and promotion of the app could come from sponsorship from governmental organizations, academic institutions, or pharmaceutical firms. To expand the number of prospective users of the app and promote early diagnosis and treatment, it is also crucial to raise awareness of dementia among the general public. Relationships with advocacy groups, professional associations, and healthcare organizations could assist spread information and connect with target audiences. Therefore, the development of a mobile app for dementia patients necessitates a thorough strategy that takes into account legal, financial, and public health considerations.

3.3. Project requirements

3.3.1. Functional requirement

- Extract data from the image
- Identify the person who is captured.
- Provide description of the captured person.
- Display the memory with that person

3.3.2. Non-functional requirement

- Availability
- Security
- Compatibility

3.3.3. User requirements

- User must have a smartphone with a working camera.
- User must have basic English knowledge
- User should not be severe level dementia patient .

4. Budget and justification

Table 4.1 : Budget justification

Item	Cost (Rs)
App publishing cost on google play	5000.00
Backend hosting cost	10,000.00
Manufacturing cost of IOT device and system	40,000.00
Paper publishing cost	5000.00
Total	**60,000.00**

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5. Appendices

Gantt Chart

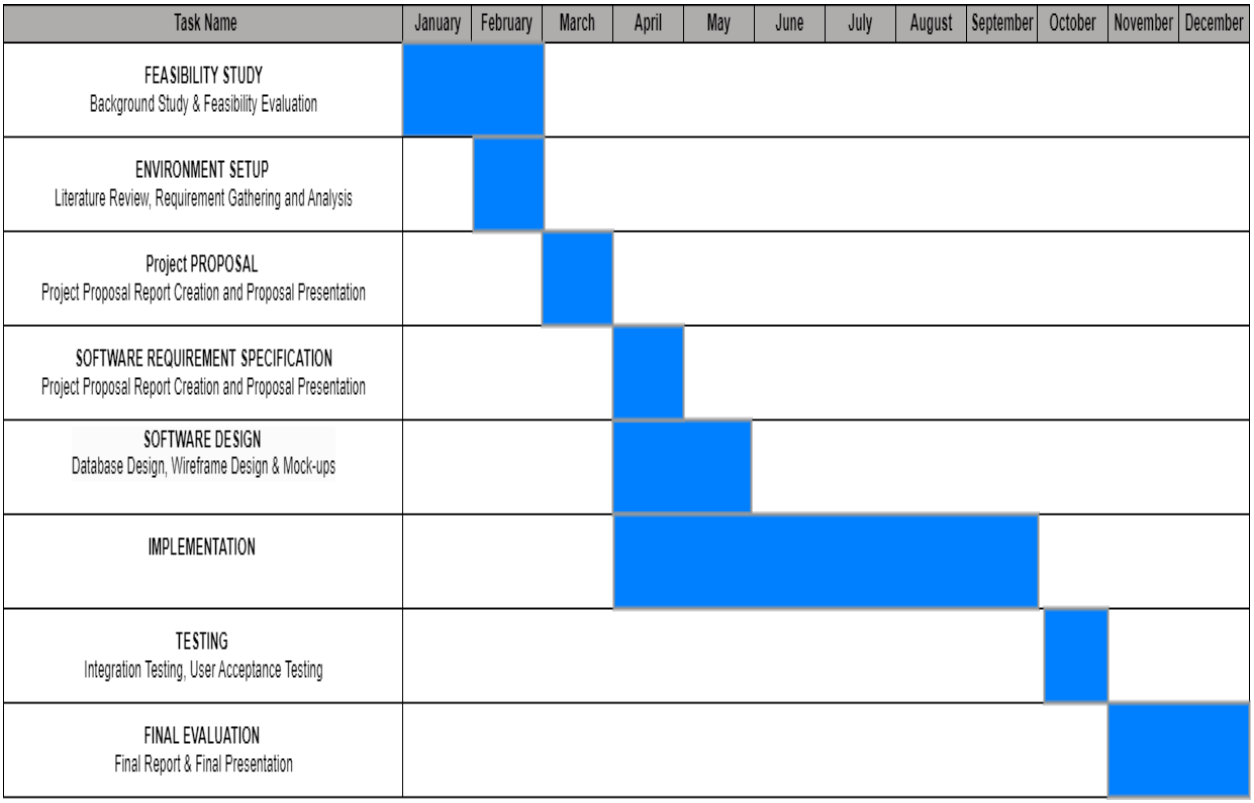

Figure 5.1:Gantt chart

Work Breakdown Structure

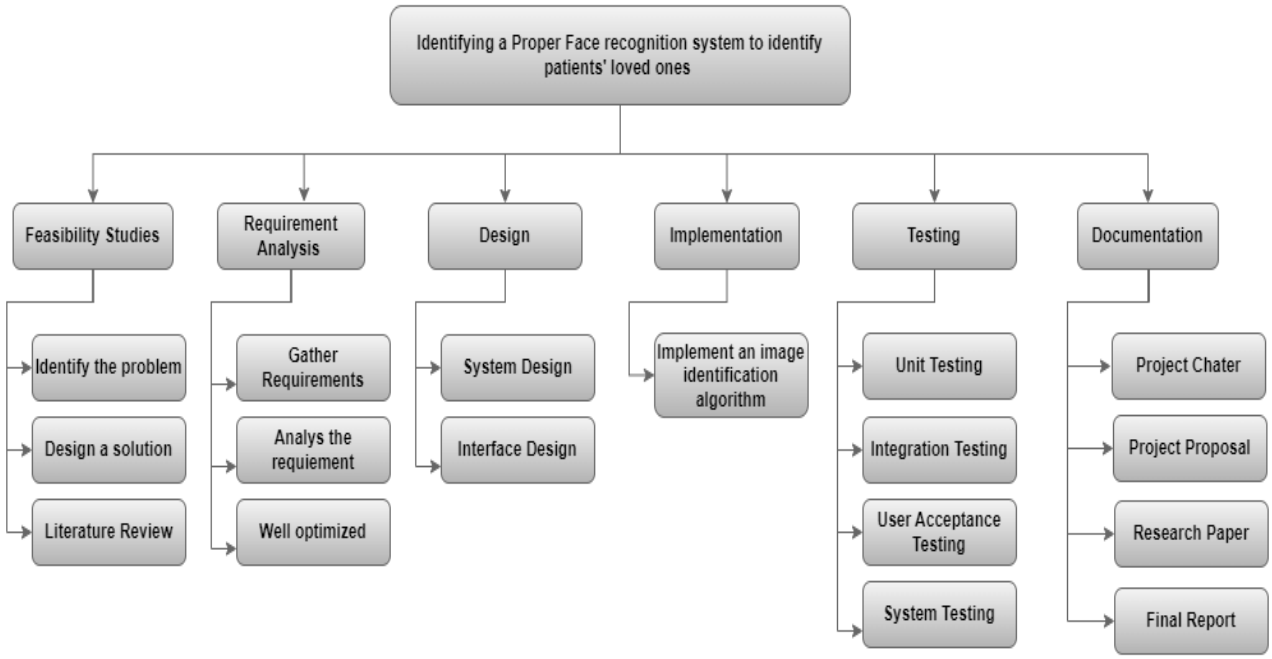

Figure 5.2: Work Breakdown Structure

Online Survey

Survey Conduct in order to get details on developing a mobile application for dementia patients.

Dear Respondent,

I'm Final year student from the department of Information Technology, faculty of computing, SLIIT.
I'm researching face recognition mobile application for dementia patients for improve their quality of life.
Patients with dementia frequently experience short-term memory impairment, making it challenging for them to recognize familiar faces, including their own and those of their friends
and relatives.

This survey is conducted to gather some data required to proceed with the research.

adpm.arandara@gmail.com (not shared) Switch accounts

*Required

Age *

- Below 18
- 18-30
- 31-50
- Above 50

Have you heard about Dementia? *

- Yes
- No

Do you have any experience with Dementia patients? *

- Yes
- No
- Don't know

How important do you think having the ability to identify their loved ones and familiar faces for maintain an independent life? (Rate 1-5) *

	1	2	3	4	5	
less Important	○	○	○	○	○	Most important

Imagine, your close relative cannot identify you . Do you think it will affect you emotionally ? *

- Yes
- No

What do you think about the most easy and effective for dementia patients to recognize familiar faces, including their own and those of their friends and relatives? *

- Getting help of a third party
- Using an assistive tool
- Repeating the names of people frequently
- Other:

Do you think all the dementia patients have ability to get some help from third Party? *

- Yes
- No

For new assistive tool, what do you think **most suitable** one for dementia patients? *

- Face Recognition App only give the description of person in- front.
- Face Recognition App with memory recalling option of captured person.
- Other:

For face recognition application, which kind of features do you think suitable to use with dementia patients? *

- Simple Interface
- Memory popup feature with the description of captured person
- Minimal distractions
- Complex Interface
- Data privacy
- Audio cues
- Other:

Are you aware of the existence of face recognition apps with memory popup feature for dementia patients? *

- Yes
- No

How effective do you think the application was in assisting with memory recall for people with dementia.? *

	1	2	3	4	5	
Less effective	○	○	○	○	○	Most effective

Do you think that face recognition applications are a helpful tool for dementia patients? *

- Yes
- No

What aspects of face recognition application for dementia patients do you believe are the most affected for identifying their familiar faces? *

- Feel them anger
- Make their lives more independent
- help them feel more comfortable and less stressed.
- Help them to feel alone
- Other:

Thank you for your Support !

Submit Page 1 of 1 Clear form

Plagiarism Report

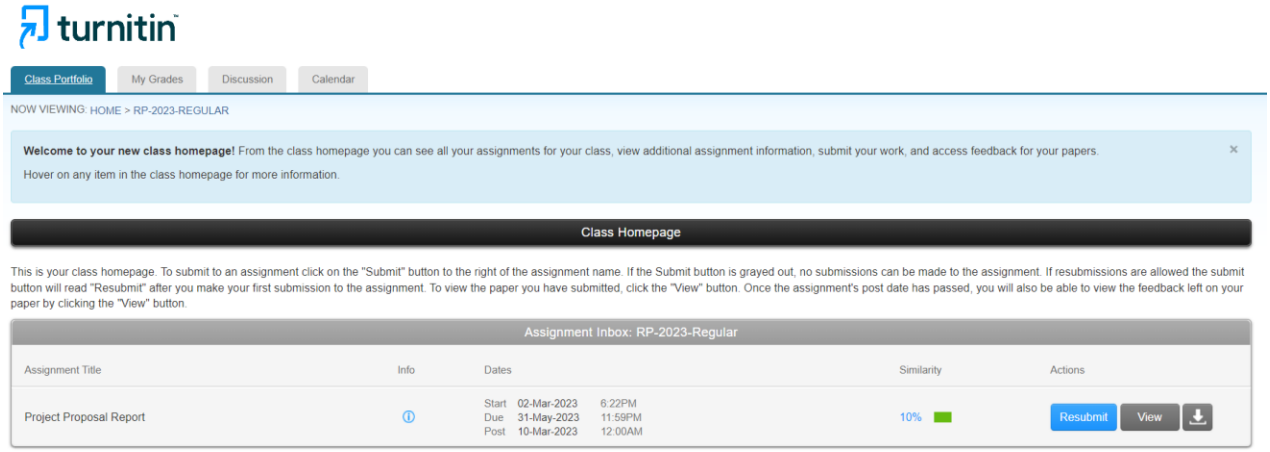

Figure 5.3: Plagiarism Report